Looking inside asteroids and comets with Radio reflection tomography technique

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Low frequency radar (HF and VHF) can be used to image the interior of asteroids and comets. The rationale for imaging the interiors of these bodies includes both scientic and pratical arguments. The small bodies in our Solar System are of scientific interest because of the information they convey regarding the early conditions and processes which led to the solar system and planets. The interior structures provides information related to the manner in which these objects were built and evolved and to the conditions in the early solar system. Practical arguments for exploring the interiors of asteroids and comets are related to the potential for mining these bodies and for impact risk mitigation. Knowledge of the interior structure is required to determine the best strategies to use for impact risk mitigation.

In this paper, we propose an instrument that can provide a three-dimensional volumetric image of the object. This scheme is analogous to the x-ray CT-Scan imaging system. In order to obtain a three-dimensional volumetric image of an object with high propagation loss, one has to view it from all directions. For small objects such as asteroids and/or comets, this is easily achieved. The first attempt in collecting radar data from such objects will be carried out by CONSERT experiment on the Rosetta spacecraft that is specifically designed for comets which tend to be more transparent to VHF radio waves. CONSERT instrument will provide bi-static radar data between the orbiter and a lander to gather information on the internal property of the comet. This paper will solely focus on radio reflection tomography technique which is based on collecting monostatic measurements from a single orbiter. We show that the radio reflection tomography technique is well-suited for exploring the interiors of both asteroids and comets although it may not be as optimal as transmission tomography for VHF-transparent comets. Benefits of the reflection radio tomography instrument include: 1) a simpler and lower cost implementation since the technique is mono-static and does not require a lander; 2) a higher spatial resolution capability due to the inherent nature of the mono-static measurements which is sensitive to the high spatial frequency features of the object; and 3) the technique produces useful images of the interior even if complete penetration is not obtained. This is particularly important for asteroids whose interiors may be difficult to penetrate with a transmission experiment

This paper will describe the principles of the radio reflection tomographic technique and show how the collected data can be used to produce a three-dimenstional volumetric image of the object.

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